Module 5: Science

Materials Needed

- Copies of the VELS
- Handouts
- VCR and videotapes (optional)
- Flip chart, tape, and markers
- Collections of leaves, rocks, shells or other interesting items children explore
- Examples of science tools-magnets, magnifying glasses, tweezers, eyedroppers, flashlights, scales, balances, ramps, etc. (optional

Goals and Objectives

As a result of this module, participants will:	*Related Northern Lights Core Knowledge Areas*
Understand the process skills of science (also known as science as inquiry)	Teaching and Learning
Recognize when and where science is taking place, both indoors and outdoors and become intentional about offering science learning opportunities	Teaching and Learning
Become familiar with the role of adults in stimulating children's play, curiosity, and knowledge of science	Teaching and Learning; Family and Communities
Recognize how science is connected to other learning domains	Teaching and Learning
Understand children's development of inquiry and how it changes over time	Child Development; Teaching and Learning
Explain science as inquiry to parents and other adults	Family and Communities; Teaching and Learning
Become familiar with professional resources and current research about science and young children	Teaching and Learning; Professionalism and Program Organization; Health and Safety

Note ☞ Page references to the Science domain in the Vermont Early Learning Standards in this module are noted as: "VELS" followed by the page number. For example, VELS Pg. 20. Relevant pages for this module are 16-17, 27, and 31.

Module 5: Science

Introductions and Opening Activity

1. Make sure participants and the instructor introduce themselves, including pertinent information about their work and work settings.
2. Instructor opens this module by acknowledging that traditional high school science instruction is focused on reproducing scientific discoveries instead of directly engaging people in making their own discoveries. Consequently some of us were turned off by science in high school. Many of us learned the scientific method by memorization, and applied it linearly. In actuality, children and adult scientists have much in common–they play around with science; and they make discoveries using a structure that is much more fluid than what we were taught in middle and high school.
3. Choose an opening activity from among the following options:
    - Handout 1: Stringing Along (Pair)
    - Handout 2: Add Water: How Does it Change? (Small group)
    - Handout 3: My Science Autobiography (Individual)
    - Reflect and then brainstorm a list in response to this question: "What did you do today with children that you would call science?" "What did you do in your own life?" (Group)

Review the Standard and Domain

- Have everyone read the Introduction to the Science domain in the VELS, Pg. 16.
- Refer to *Handout 2* (if completed during the opening activities) or conduct the activity in *Handout 2: Add Water: How does it Change?*
- Participants should refer to the VELS Pg. 16 examples column and identify examples from the list that were experienced during the *Add Water: How Does it Change?* activity. Discuss how these examples fit with the VELS Science learning goals.
- Make a list of science action words. These are the process skills of science.

The Development of Scientific Thinking

Instructors should use the following key points to develop a mini-lecture on the topic of the development of scientific thinking in young children:

Children are natural scientists.
They are curious and actively explore their world in order to make sense of it. Early childhood programs offer children an opportunity to expand their explorations and deepen their curiosity while developing theories of how things work, why things happen, and so on. These theories may be developmentally appropriate, but scientifically inaccurate. Adults can provide information, challenge their thinking and strengthen children's understanding of the world around them in an effort to correct children's misconceptions.

Science learning includes knowledge of the process skills and content areas of science.

Process Skills: The process skills are the "hows" of science and include:

- Asking questions like "what's this?" "What happens if…?" "How could I…?"
- Collecting and using data-documenting what they observed in order to explain something
- Communicating information and ideas-sharing observations and results with others through charts, drawings, and conversation
- Designing and making models-building from a plan, creating models
- Estimating and predicting-making informed guesses about quantity, what might happen, cause and effect
- Experimenting-doing investigations and research
- Finding patterns-noticing repeated sequences, organized arrangements, how one thing influences another
- Measuring-in terms of size, weight, length, temperature using standard (numbers) and non-standard units (hands, shoes, books, etc.)
- Noticing change over time-observing and describing how objects and living things change
- Observing-using our senses to notice and explore the world around us
- Recognizing relationships-making connections and comparisons between objects, living things and events in the world around us
- Sorting and classifying-making comparisons and then organizing them into groups and categories
- Using tools of science-exploring with the use of tools such as magnifying glasses, eyedroppers, balances, microscopes, etc.

Content Areas: The content areas are the "what" of science and include:

- Physical Science (Space, Time and Matter)–This involves exploration of the objects, materials and events of the nonliving world in children's everyday lives. It also involves properties of the earth including weather, seasons, night and day, rocks, water, and soil.
- Life Sciences (or the Living World and the Human Body). This involves observing living things and noticing the diversity and variation of living things including plants, animals, humans and other organisms. Areas to study include basic needs, life cycles and dependence on one another and the environment.
- Earth and Space Science (or The Universe, Earth and the Environment). This involves climate, the solar system, rocks, water, night and day, and the seasons.

Aspects of the young child's development that are similar to the attitudes of a scientist include:

- Children are curious-they explore, investigate and want to know why
- Children are persistent-they keep at it until they get a result

- Children want to see evidence-their questions about why things happen can be answered with documentation or real data that is collected when they explore
- Children learn in social groups-constructing new ideas by playing, discussing and working with others is at the heart of what both children and scientists do.

Children's inquiry develops and matures over time.
This is true about life in general, but especially true with regard to scientific inquiry. At first they **notice, wonder and explore** freely with little guidance from adults. Adults may further their inquiry by encouraging them to **ask questions and take action** to answer their questions. With additional support from adults, they may **focus observations and clarify questions** that can provide needed information. With better questions, they engage in **focused explorations** to answer their questions. Together with adults, they can **draw conclusions** and **share their ideas**. (See *Handout #4: Young Children's Inquiry*)

Asking questions is one of the process skills of science.
Helping children form questions and then focus them is a skill for adults to develop. Open-ended questions are the best kind of questions to ask because they encourage higher-level thinking. Some examples of open-ended questions are:

- Comparing questions-what's the same (different) about these?
- Connecting questions-what does this remind you of? Where else have you seen something like this?
- Predicting questions-what do you think will happen if...?
- Evaluating questions-what do you like (dislike) about this? Why?
- Interpreting questions-what do you think about that? What does this mean to you?
- Observing questions-what does it look/sound/smell/feel/taste like? What do you notice?
- Explaining questions-why do you think that happened? Why did you decide to...? How did that happen?

What Does Science Look Like?

What does Science look like and how might teachers observe it in young children?

The process skills of science and the interest in science content areas can be observed in children's play whether or not the adults have intentionally planned a science lesson. While increased intentionality about science instruction is a goal of this training module, it is helpful at this point to observe children's play and identify the processes and content that we would call science.

Activity: What Does Science Look Like?

1. Using visuals of children at play such as videos or video clips, photographs from magazines, journals, calendars or classrooms have participants work in pairs or small groups.
2. Have participants list the process skills they see happening in the videos or images.
3. Using the list they complete, have participants translate their language into the language of the VELS Science examples, learning goals and definitions.
4. Instructors should help participants see the connection between play and the process and content of science. Participants can share their discoveries through group discussion and reporting back.

Reflecting on Science

Instructors should summarize (or ask the group to summarize) what's been covered so far, especially the process and content of science with young children. Choose among the following options for individual writing activities that offer a chance to reflect on one's own practice and assimilate new learning and experiences.

- If you did either of the experiential opening activities, *Handout 1: Stringing Along* or *Handout 2: Add Water: How Does it Change?*, have participants review what they identified as the science in the activity and see if they would add or change anything now.
- Have participants rewrite "My Science Autobiography" and add or edit them based on learning in this module about science process and content.
- Have participants reflect on an interaction they had with a child this week (content of interaction should include questions, answers, discoveries, etc.) Ask, "How would you change that interaction to make the most of a science learning opportunity?"

The Adult's Role in Supporting this Domain

- Refer participants to the list in the VELS, Pg. 17, entitled "Adults Support the Development of Children's Scientific Thinking by…". Ask participants to pick one item from the list that comes naturally to them, and one they would like to develop. Share with a partner.
- Read a children's book, such as *Jody's Beans* by Malachy Doyle (Candlewick Press, 1999) and discuss how this book might be used with children to introduce or reinforce scientific thinking skills.
- Review the concept of open-ended questions. (See *Handout 5: Talk Makes All the Difference*, and *Handout 6: Questioning Strategies*)
  - ? In small groups, generate a list of questions about the *Add Water: How Does it Change?* investigation. Make sure you have at least five closed questions,

and five open-ended questions. What kinds of questions would children ask about this investigation?

- Instructors are encouraged to bring in collections of items to explore. Some examples: seedpods, leaves, rocks, or shells. Participants can:
  - ? Explore these items as children would
  - ? Practice developing open-ended questions
  - ? Predict the questions children might ask and then
  - ? Work to focus or clarify the children's questions
  - ? Select some questions that could be turned into a science investigation, then describe the investigation

The Role of the Environment in Supporting this Domain

Classroom and home environments, either indoors and outdoors, can either encourage children's scientific thinking, or miss the mark entirely. The selection, storage and display of materials, the organization of learning centers, and the schedule and time allowed for explorations are examples of aspects of the environment that can be a support to children as they develop scientific inquiry and knowledge.

Activity: Environmental Scan for Science

1. Instructors choose whether to have participants do this individually, in pairs, or in groups of teachers who work together.
2. Make a mental inventory of materials they have that they would call science tools
3. How do the children use these tools? How do they advance the children's scientific thinking?
4. How many different learning centers or areas of the room can these tools be used in? (Example: bringing the balance scale to the book area to see which books are heavier, board books or paperback)
5. What tools or materials would do children use from the outdoors? What can you bring from outside and use indoors? What can you take outdoors that are usually used inside?
6. What do you consider a science tool now that you didn't think of as relating to science before this module?

Note ☞ Instructors should have participants review the list in the VELS, Pg. 17, "The Environment Supports the Development of Children's Scientific Thinking by…" discuss them and add to the list.

Reflecting on the Role of the Adult and the Environment

Instructors should have participants do this as an independent writing activity and then share with a small group.

Think about a theme or unit of study that you do with children every year. Some examples: apple picking, taking a field trip to the pumpkin patch, observing tadpoles, or making soup for a center-wide feast. Answer the following questions:

- Using what you've learned and experienced in this module, how would you make that theme or activity a richer and deeper scientific experience for children?
- How would you introduce the investigation or activity to bring out the science in it?
- What children's books could you use to support the learning in this activity?
- Identify the learning goals and definitions from the VELS that this theme or activity supports.

Putting it All Together

Instructors choose from among the following synthesizing activities, and then have the group share the results:

- The National Science Foundation has awarded a grant to the state of Vermont to distribute $1000 to each early childhood program. How would you use this grant award? Provide a rationale for your choices.
- **Scenario:** You have just made a presentation to your center's board or policy council on a recent field trip to the frog pond. One board member questions your choice of outings, saying that it sounds like a science related activity, and everyone knows preschoolers can't do science. She says science is something children learn in fifth grade. How do you respond?
- **Scenario:** Using the same premise as the one above, how do you respond to a different board member who comments, "Oh I see, that's just playing…" You want to make sure that they understand how the learning goals of the VELS are being addressed by this outing, as a way of strengthening their understanding of the educational program for children.
- **"Science Underway Here":** Participants create statements that can be made into signs to post in the learning centers in their classrooms or homes about the science in children's explorations in each learning center. Have them make a mental inventory of the learning areas in their room, and one or two ways children do science in that area. They may take these statements home and use a word processor or write them out in bold letters so other teachers, parents and volunteers will understand the science learning that is involved in children's play across content and learning areas in a classroom or home.

- Pick an open-ended question from *Handout 6: Questioning Strategies*. Use the question to:
  - ? create an investigation
  - ? identify materials needed to conduct the investigation
  - ? describe how you will model or instruct children to use the tools
  - ? describe how you will document the learning that resulted from the investigation
  - ? describe how you will communicate with families about this investigation and the learning it promoted.

Conclusion

Instructor should lead participants in compiling a group list of what was learned or how their perspectives changed as a result of this science module. Make sure to include

- The process skills and content areas of science,
- The relationship between science and the other domains of the VELS,
- How attitudes and knowledge of adults can support or hinder children's developing scientific thinking,
- The use of questions in promoting scientific thinking
- How adults shape the environment that promotes scientific thinking, skills and knowledge.

Handout 1: Stringing Along

Materials

A set of six strings 18 inches long for every two people, or a couple of balls of string and scissors

Time

15 minutes

Goal

Emphasize open-ended questions and that there are multiple answers to a question

Room Arrangement

Arranged so it is easy to work with a partner.

Instructor

1. Have participants find a partner.
2. Each pair will need a set of six strings about 18 inches long. It is easier and quicker to have the strings cut ahead of time, but it could be a task of the pairs.
3. In each pair, one person holds the strings in the middle while the partner ties two ends together (on the same side of the partner's hand) until all strings are tied. (three sets on each side of the hand).
4. Participants then predict what shape they will have when the hand is released and the string is opened.
5. As pairs make their predictions, illustrate their ideas on chart paper or white board. Then open the strings and see the various shapes that were achieved. Even though everyone followed the same directions there will be different correct answers.

Note There is no one correct answer, although we are encouraged to support our ideas with what we find out through experimenting and trying out ideas.

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Handout 2: Add Water: How Does it Change?

Materials

4-6 objects per group. Suggested objects: a strip of paper towel, a piece of ice, a plastic toy, a small amount of soil or clay, paint, a piece of cracker or cereal. The idea is to have objects that will behave differently when placed in water–creating no change, absorbing water, dissolving or dispersing.

Cups (one cup per object is ideal)

One container of water per table

Room Arrangement

Participants in small groups around tables to share materials, and a have discussion

Time

20-25 minutes

Goal

To have participants conduct a simple investigation, discuss ideas, make predictions and observations

Instructor

1. The instructor should start the activity by saying, “In small groups you will be doing a simple investigation to see what happens when various objects are added to water. “
2. Before adding the water, make some observations of the objects you’ve been given and make some predictions–what do you think will happen when you put these objects in the water? Have someone in each group write down the observations and predictions you discuss.
3. Next put each object in a cup and add water. Observe what happens. Describe any changes you notice. Can any of the objects be grouped together based on how they change? Write down or make sketches of things you notice.
4. Have the small groups share discoveries with each other. If the small groups have some different objects they can compare and group their findings as a large group.
5. Discussion-How does this activity relate to the VELS, Pg. 16, “Learning Goals and Definitions?”
    - Play-using play to ask questions and discover
    - Science knowledge-using senses to investigate change
    - Science skills & methods-making simple observations, predictions

Handout 3: My Science Autobiography

Materials

Paper and pens or pencils

Time

5 minutes

Goal

To recall influential people and events that shaped participants attitudes toward science learning throughout their lives.

Room Arrangement

No specific set up is required

Instructor

1. Instructor asks participants to recall their early experiences of science in school or other organized instruction (after school activities, camps, etc.) What do you remember about these activities and the people involved? How do you think these activities and individuals influenced your knowledge about science? How do you think they influenced your attitude about science and scientific learning? How would you describe your knowledge, attitude and beliefs about science today?
2. Discussion-The instructor asks participants to share portions of their autobiography and draw conclusions about how their early science instruction shaped their current knowledge, attitudes and approach toward supporting young children's scientific explorations.

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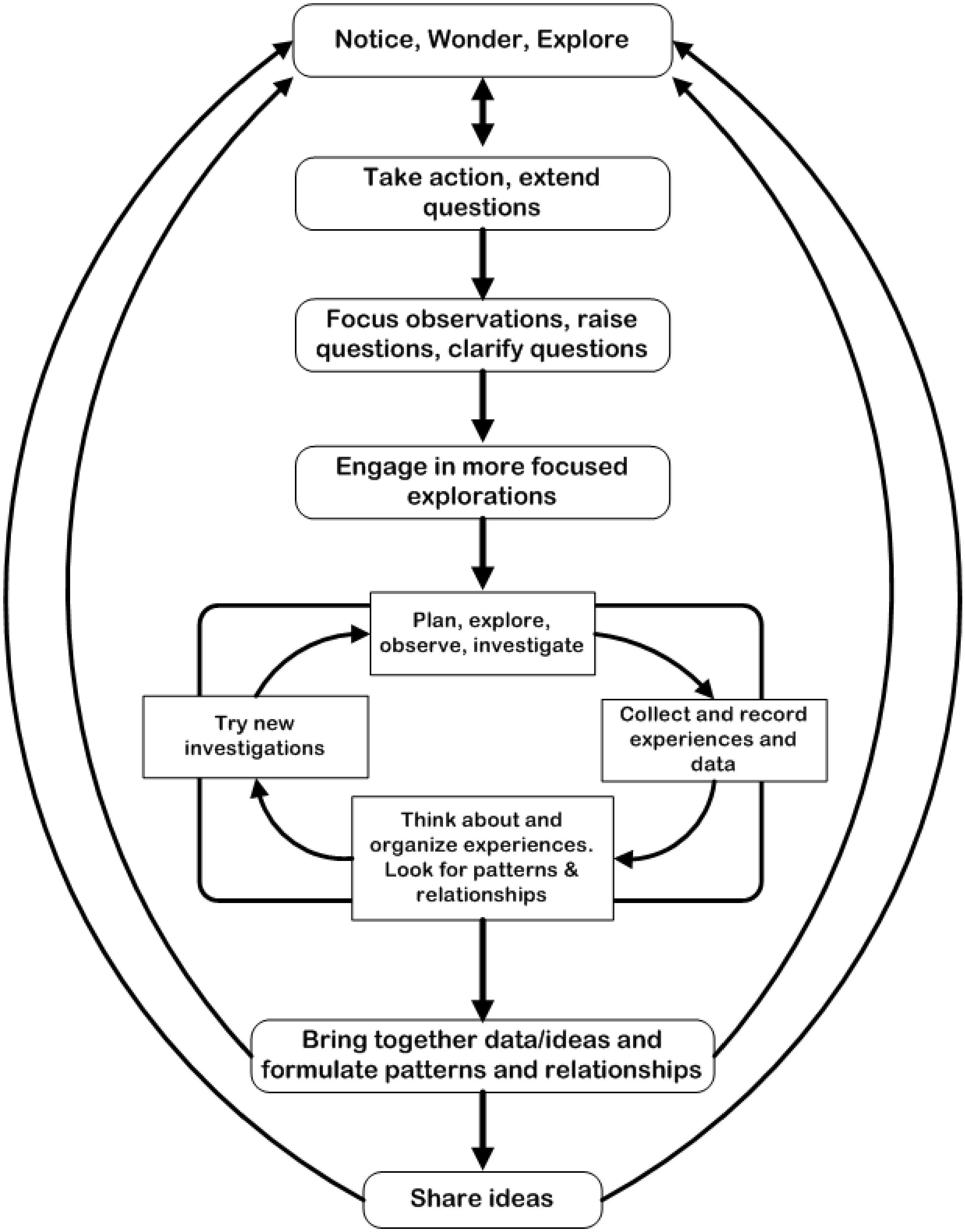
Handout 4: Young Children's Inquiry



Hubert Dyasi, CCNY
Karen Worth, Education Development Center, Inc.

Handout 5: Talk Makes All the Difference

Learning happens through social interaction. Talking with others helps us make sense of our own ideas and we learn from the thinking of others.

Here's what you can do to encourage conversations in your sessions:
Be an active listener-make eye contact, paraphrase as you're listening, and ask questions.

Give participants plenty of time to engage their thoughts when asking questions or eliciting comments.

Structure sessions so that participants can talk to each other: in pairs, in small groups and in the large group.

Encourage participants to share their own experiences implementing the program-allow time for participants to comment, offer praise or make suggestions to one another.

Encourage participants to bring in examples of children's work and share successes and challenges.

Encourage educators to increase the level of communication with families through bulletin boards, newsletters, open houses, conferences, and family investigations.

Be available to educators between sessions.

Model open-ended questions for participants and encourage them to use this strategy with children.

Model using math and science vocabulary during sessions.

What are open-ended questions?
If every discussion question you ask elicits a 'yes' or 'no' answer you're not asking open-ended questions.

Learning how to ask open-ended questions takes lots of practice. These kinds of questions encourage higher level thinking. Here are a few examples:

Comparing questions

What's the same about these?

What's different?

Connecting questions

What does that remind you of?

What do you notice about this character that reminds you of someone you know?

Where else have you seen something like this?

What is there about this place that reminds you of this classroom, your home, our town?

What other story have we read that reminds you of this story?

Predicting questions

What do you think will happen now/next/if.. ?

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Evaluating questions

What do you like about this? Why?
What don't you like? Why?

Interpreting questions

What do you think about that?
What does that mean to you?

Observing questions

What does it look/sound/smell/taste/feel like?
How would you describe that?
What do you notice …?

Explaining questions

Why do you think that happened?
Why did you decide to …?
How did you do that?

From Mother Goose Cares About Math and Science. Vermont Center for the Book, 2004. www.mothergooseprograms.org

Handout 6: Questioning Strategies

Adapted from Jos Elstgeest, "The Right Question at the Right Time," in Primary Science: Taking the Plunge, ed. Wynne Haden, Heinemann Educational Books, 1985.

Questioning is one of the most important tools in guiding and extending student learning. The examples listed here can help you develop your own strategies to enhance your students' investigations and thinking.

Attention-Focusing Questions

Have you seen?.

Do you notice?

What does it do?

What do you see, feel, hear?

These questions help students focus on observation/details as well as connect to the phenomena.

Measuring and Counting Questions

How many?

How long?

How often?

These questions help students develop confidence because they can be answered directly from the activity experience.

Comparison Questions

In what ways are ________ the same/different?

Can you describe an order or pattern to ______________?

In what ways can you classify/categorize ______________?

These questions can help students to focus their observations as well as to classify/categorize/order the materials or their findings.

Action Questions

What happens if ___________?

What happens if you don't ________________?

These questions help students explore new materials, properties, forces, and/or events. They can be answered by simple experimentation.

Problem-Posing Questions

Can you find a way to __________________?

This question involves students in authentic problem-solving situations. It supports inquiry, critical thinking, and experimentation.

Reasoning Questions

What do you think about ___________________?

Why do you think that ____________________?

These questions stimulate students' reasoning and help them draw conclusions and generalizations and to expand or change their ideas. Ask these questions after the students have had the experience they need to reason from evidence.

The types of questions above focus on guiding the children's investigations into the materials and concepts of science activities. It is also important to help them to look at their process of working through an activity and at their own thinking. The following questions have this goal, and are especially useful as writing prompts. (Adapted from Jeanne Reardon, “Developing a Community of Scientists,” in Science Workshop, ed. Wendy Saul et al., Heinemann Educational Books, 1985.)

Metacognitive Questions

What have you discovered?

How do you know?

What do you wonder?

What will you do next?

How do you decide what to record?.

What helps you do science?

How do you know when to stop, that you are finished?

Do you ever give up your idea/question/explanation? When? Why?

Science Professional Resources

Chalufour, I., & K. Worth. Building structures with young children. St. Paul, MN: Redleaf Press, NAEYC, 2004.

Colker, L.J. The cooking book: Fostering young children's learning and delight. Washington, DC: NAEYC, 2005.

Harlen, W. and S. Jelly. Developing science in the primary classroom. Portsmouth, NH: Heinemann,1989.

Mother Goose Programs. Mother goose cares about math and science. Chester, VT: Vermont Center for the Book,2004.

Parnella, D. Project seasons. Shelburne, VT: Shelburne Farms Museum,1995.

Worth, K. and S. Grollman. Worms, shadows, and whirlpools. Portsmouth, NH and Washington, DC: Heinemann and NAEYC, 2003.

Young Children. 57(5) September, 2002. This issue is devoted to Teaching and Learning about Science and has many relevant and informative articles..

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Supplemental Material

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